Soil respiration CO$_2$ test: Potential N-Mineralization

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Concept

Soil Organic Matter

Microbial Respiration

CO₂ and Nitrogen release
Introduction

- Microbial respiration of soil organic matter releases $\text{CO}_2$ and nutrients (N, P) to crops.
- Laboratory methods for Soil CO2 Respiration are time consuming and cumbersome.
- Methods to predict mineralization of N+P from SOM have not been widely adopted in soil labs.
  - Examples: PSNT, ISNT, 7d-Aerobic N-min
  - Other calculations: SOM x factor
Development of soil respiration CO$_2$ testing

- Need to adapt CO$_2$-respiration method for adoption by commercial labs.
- Application of a thin-layer gel-dispersion phosphate CO$_2$ buffer.
- Proved high $r^2$ with existing methods (GC, IR and base-trap methods).
- Developed inexpensive spectrometer to quantify response.
Comparison to other CO$_2$ methods

Base Trap Titration

Infrared cell (IRGA)
How does 1d test compare with traditional 28d basal respiration? (time and cost a big factor for successful implementation)
NRCS soil respiration

- Standard volume of soil
- Visual color chart system based on Doran model of field respiration
Laboratory application

- Focus on drying-rewetting phenomena
- Standardized moistening method
- DCR spectrometer for accuracy
1- Pre-dried soil is bottom moistened
2- Insert CO$_2$-sensitive probe into sample jar;
3- Read probe after 24h for ppm CO$_2$-C;
Range: 0 – 120 ppm
Soil Re-hydration

- Helps standardize CO$_2$ test process.
- Drying-rewetting mimics natural systems
  - Plants turn greener after it rains due to the release of N and P, not just the water.
  - Evidence suggests that the majority of nutrient cycling is due to the drying/rewetting effect.
- CO$_2$ test from rehydration focus of increasing utilization
- Research shows tight correlation to biomass
Drying-Rewetting CO$_2$ Pulse

- Rewetting soil activates microbial mineralization
- Consistent with repeated d/w cycles

**Fig. 2.** Rates of total CO$_2$ production before and after rewetting.

Source: Fierer and Schimel 2003  Soil Sc Soc Am J 67
Soil respiration CO$_2$ relates to Biomass

Soil Microbial Biomass Carbon

 Soil respiration CO2 result

$R^2 = 0.1932$
N-Min from Manured soils

Net N-Release in Relation to 24-h CO2 Burst Following Compost Applications (Com_Appl n-avail = 3ppm)

\[ y = 1.2599x - 7.3566 \]

\[ R^2 = 0.981^{**} \]
Background:

N-release from SOM correlates to CO$_2$-Burst

**Graph:**

USDA-ARS 2006-2008 Control plots
Plot size = 4.5 acres Temple, TX

- **Regression Equation:**
  
  $y = 1.86x - 11.8$

  \[ r^2 = 0.84 \]
TX SOIL CO$_2$ RESPONSE TO MANURE

Compost field applications linearly correlated to 24h CO$_2$ burst by two methods

Chart 1

Base Trap CO$_2$

\[ y = 23.27 + 0.281x \]
\[ r^2 = 0.87 \]

KIT CO$_2$

\[ y = 1.77 + 0.0095x \]
\[ r^2 = 0.92 \]
7d N-min vs Soil Respiration \( \text{CO}_2 \): Relationship consistently 1:1
Soil respiration advantages

- Replaces complicated base-trap and IRGA methods which are cumbersome
- Replaces fumigation Biomass (SMBC) test
- Direct substitute for 7d N-min anaerobic test
- Readily integrated into routine soil test algorithm
Summary, cont.

- Fields with high CO$_2$ rate tend to be very productive.
- Soil respiration compliments other soil quality tests.
- New method unifies and simplifies lab process.
- After set-up, 200 samples can be read per hour.
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1. Doran, J T Kettler, M Tsivou (1997) *Field and Laboratory Soil Test Evaluation* USDA-ARS, Univ Nebraska, Lincoln


